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Understanding and interpreting the VMmark benchmark

Introduction

Using virtual machine technology to run multiple virtual servers on a single physical server continues to grow in importance as the IT industry searches for ways to more efficiently use hardware compute resources in the data center.

Traditional benchmarks are typically designed to test the performance and scalability of a server performing a single large-scale task such as database serving or web serving while running under a single operating system. Results of these types of benchmarks, however, do not provide a reliable indication of the server's ability to scale when running multiple virtualized systems in a virtual machine environment.

VMmark, which was developed by VMware and introduced in 2007, was the first and is still the dominant benchmark designed specifically to measure and compare virtualized system performance for servers.

Structure of the VMmork benchmork

As a VMware product, the VMmark benchmark works solely with the VMware ESX hypervisor; therefore, it cannot be used to measure the relative performance of other VMM solutions such as Windows Server 2008 Hyper-V or Citrix XenServer. VMmark can be used to gauge the relative virtualization performance of different server platforms when running the ESX hypervisor.

The Tile – VMmark's basic unit of work

VMmark uses a set of six virtual machines, each running a particular operating system and application workload, to define its basic unit of work – the tile. Table 1 shows a detailed breakdown of the operating systems and common data center applications that comprise each of the six virtual machines in a tile.

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Table 1-1. VMmark warklaad summary per tile

Warkload	Applicatian	Virtual Machine Platform
Mail server	Exchonge 2003	Windows 2003, 2 CPU, 1 GB RAM, 24 GB disk
Java server	SPECjbb2005-bosed	Windows 2003, 2 CPU, 1 GB RAM, 8 GB disk
Web server	SPECweb2005-bosed	SLES 10, 2 CPU, 512 MB RAM, 8 GB disk
Dotobose server	MySQL	SLES 10, 2 CPU, 2 GB RAM, 10 GB disk
File servers	dbench	SLES 10, 1 CPU, 256 MB RAM, B GB disk
Standby server	*None*	*Windows 2003, 1 CPU, 256 MB RAM, 4 GB disk*

To ensure the benchmark's standardization, VMmark specifies how each virtual machine is configured, including memory, disk, and number of CPUs. This is also shown in Table1.

Client systems are also required to drive the workloads on the tile of the server under test. Each tile requires a separate client system, and the configuration and software to be run on the client is also strictly defined.

Calculating a Tile's performance

A VMmark test run is designed to last for three hours. During this time, the system collects metrics on the performance of each of the five virtual machines in the tile that are actually running workloads. The results for each virtual machine are then compared against those obtained when running a single tile on VMmark's defined reference system to generate a normalized performance ratio for each virtual machine. Finally, a geometric mean of these five numbers is taken to arrive at the performance score for the tile. Because the performance numbers are taken as ratios against the VMmark reference platform, tile performance scores tend to gravitate around one. In fact, since the reference system for all VMmark results is defined as an HP ProLiant DL580 G2, the performance score for a DL580 G2 running a single tile is exactly 1.00.

Running multiple tiles

The VMmark benchmark can be set up to run a single tile or multiple tiles. Deciding how many tiles a given platform is capable of running is an empirical determination; however, platforms with more processors and more cores can generally run more tiles.

When running more than one tile, the performance results from all of the tiles are totaled to generate an overall performance score for the test. VMmark scores are always represented by two numbers – the aggregate performance scores of all the tiles and the number of tiles run. A typical VMmark score for a system would be stated as 10.00 @ 7 tiles.

Interpreting VMmork results

Interpreting VMmark results requires looking at both numbers within the score. Clearly, when comparing two systems tested with the same number of tiles, the system with the higher performance score (left number) has achieved a better result. Overall, the ability to run more tiles is the more important metric since it indicates a platform's ability to run more concurrent workloads than other systems. Also, higher performance scores will almost always correlate with higher numbers of tiles.

Because it is focused on virtualization performance, VMmark is essentially a processor and core bound benchmark. Systems with greater numbers of processors and cores will generally outperform those with fewer. While the amount of physical memory installed can make some difference, any installed memory greater than the five to six gigabytes required for each tile that the processor complex is capable of supporting is of little or no benefit. Table 2, which contains the latest VMmark results for several HP ProLiant servers, illustrates the difference that more processors and cores make in overall virtualization performance.

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Table 1-2. Recent HP ProLiant VMmark results

System	Processors	Cores	VMmark scare
ProLiant DL385 G5p	2	8	11.28 @ 8 tiles
ProLiant DL585 G5	4	16	20.43 @ 14 tiles
ProLiant DL785 G5	8	32	27.71 @ 19 tiles

Certificatian of VMmark results

VMware maintains a review process for validating and approving VMmark benchmarks. These benchmark scores are published on the VMware website: http://www.vmware.com/products/vmmark/results.html

The future for virtuolizotion ond virtuolizotion benchmorks

Updates ta the VMmark benchmark

The VMmark benchmark can be run on different versions of the ESX hypervisor, which will influence the results. When evaluating VMmark results, it is always important to compare results that use the same software platform. As of February 2009, the latest released platform from VMware is ESX v3.5.0 Update 3.

VMware has also released VMmark 1.1 in August 2008. VMmark 1.1 changes the operating systems for two of the virtual machines in the VMmark tile. The Java server and Database server virtual machines now use the 64-bit versions of the Windows and Linux operating systems respectively.

Wark an an industry standard virtualizatian benchmark

The Standard Performance Evaluation Corporation (SPEC), which is responsible for developing and maintaining standardized benchmarks used in the industry, is committed to developing standard methods of comparing virtualization performance. The SPEC Virtualization Committee, which began as a working group in late 2006, is currently working to create an industry standard benchmark that can be used to evaluate virtualization performance for data center servers. While a specific release date for this benchmark has not yet been set, the SPEC Virtualization Committee's efforts are readily available at http://www.spec.org/specvirtualization. Both HP and VMware, along with many other leading companies, are members of SPEC as well as participants in the Virtualization Committee.

Additionol resources

For additional information on the topics discussed in this article, visit the following websites:

Saurce	Hyperlink
VMware VMmark hamepage	http://www.vmware.com/products/vmmark/
SPEC Virtualizatian Cammittee hamepage	http://www.spec.org/specvirtualization/
Overview af the VMmark benchmark an HP ProLiant servers - white paper	ftp://ftp.campaq.cam/pub/praducts/servers/benchmarks/VMmark_Overview.pdf
HP VMmark page	http://www.hp.com/go/vmware/vmmark

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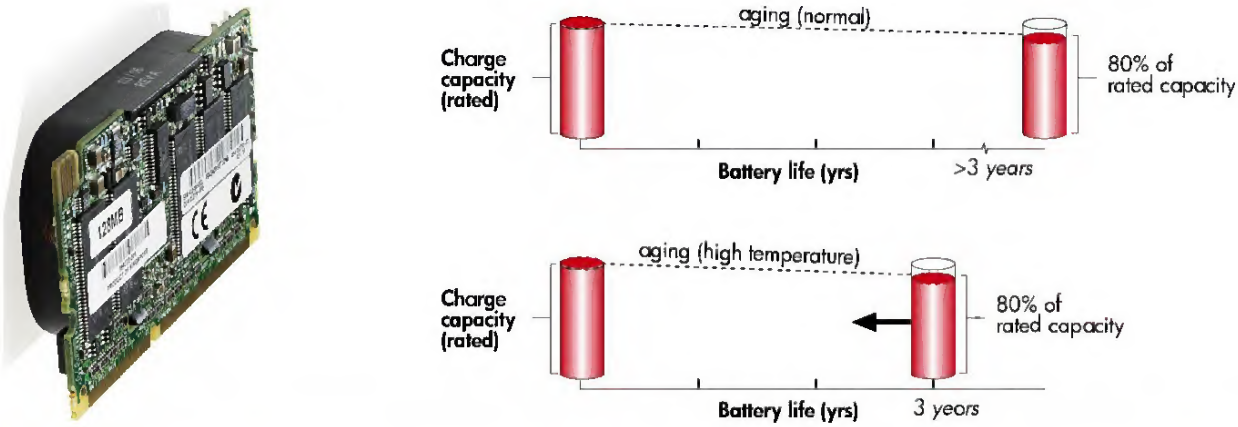
Expected life of the HP Smart Array BBWC upgrade module battery pack

The Smart Array 128-MB Battery-Backed Write Cache (BBWC) upgrade module uses a nickel metal hydride (NiMH) battery pack to retain write data if power to the system is interrupted. Two important battery pack characteristics are its charge capacity and battery life. Charge capacity, expressed in milliampere-hours (mAh), determines how long—in days—the BBWC module can retain data. A new, fully-charged battery pack typically provides 5 to 6 days of data cache retention. However, the data retention time decreases with higher operating temperature and increasing battery age. The battery pack is designed to provide 3 days of data cache retention at 80 percent of its rated capacity. Data retention time is also affected by the size of the cache. Therefore, larger caches (256 MB and 512 MB) include up to three battery modules to retain data up to 3 days.

Note
The data retention time can be extended any time the server's auxiliary power is available during system power down.

As the battery pack ages, the battery capacity decreases in a roughly linear manner (Figure 1-1). Battery aging is accelerated by high server internal temperatures. In a worst case scenario with the sever operating at its maximum temperature of 60°C (140°F), the battery pack has a life expectancy of 3 years, after which it should to be replaced. If the server's inlet temperature is maintained at 24°C (75°F) or less, then the server's internal temperature should remain below 60°C, and the battery pack may last more than three years. However, HP recommends replacing the battery pack every 3 years.

Figure 1-1. The Smart Array BBWC upgrade module is designed to provide 3 days of data retention at about 80 percent of its rated capacity. Normally, the battery pack can last for more than 3 years. However, high system temperature accelerates aging and decreases battery life.



Additional resources

For additional information on the topics discussed in this article, visit the following websites:

Resource	URL
HP Smart Array E200 Controller User Guide	http://bizsupport1.austin.hp.com/bc/docs/support/SupportManual/c00688683/c00688683.pdf
HP Smart Array 6i Controller User Guide	http://bizsupport1.austin.hp.com/bc/docs/support/SupportManual/c00217854/c00217854.pdf

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Meet the Expert—Mitch Wright

Mitch Wright is a Technologist/Sr. Engineer for ASIC and Chipset Enablement in the Technology Solutions Group-Industry Standard Servers (TSG-ISS). Mitch works with product teams, system architects, and vendors to develop high-quality, highly reliable ProLiant products on schedule. "The key," says Mitch, "is to meet the needs and requirements of our customers."

According to Ken Jansen, his manager, Mitch is fueled by his "passionate inquisitiveness. Mitch is always looking for new and better technologies to solve our customers' problems, and he is good at discerning promising technologies from those that aren't or those that will take longer to develop. Mitch also evangelizes new technologies within the company to ensure that they reach the customers."

Mitch's hands-on approach translates into his hobbies. He likes to design and build wood furniture. He says, "Working with your hands keeps you humble."

Mitch and Jenny (married for 21years) have three children: Grace (20), Claire (14), and Alex (11).

Below are excerpts from an interview with Mitch.

Name: Mitch Wright
Title: Technologist/Sr. Engineer
Years at HP: 12
University: Texos Tech University
U.S. Patents: 7
Awards: TSG 2006 MVP
Technical Papers: *In search of Accelerotion, High Speed Digitol Design: Moving from 33MHz to 133MHz PCI-X*

Why did you decide to become on engineer?

From an early age, I had a huge curiosity about how things work and I have been on a quest ever since. Growing up, I always worked with my dad in the garage and he continually encouraged me to invent stuff and build it myself. His only requirement was I use what was readily available. So the build versus buy question always ended the same way...build it.

An inventar at age 12

What is your most interesting reseorch or invention?

I have had many projects that are interesting for different reasons. For example, the ProLiant 8000 [first Compaq 8-processor server] and the DL585 G1 [first ProLiant Opteron-based server] were both significant products. I have seven patents, but I am proudest of my first patent and sole-inventor patent. Also, I worked as the Lead Technologist in the Physics Research Instrumentation Lab at the Super Collider Lab from 1991-94. It was a once-in-a-lifetime experience because I worked with some of the world's brightest physicists.

How much customer input goes into your product designs?

Customer requirements are my primary concern, whether designing computers for the data center or for scientific instruments. In the last few years, I have been fortunate not only to work with vendors but also to interface with some large customer accounts. I also interface with presales engineers at the HP Tech Tours hosted by the Technology Communications group. These interactions provide a unique opportunity to understand customer challenges and requirements.

How do you drive customer input into the design of your products?

We work hard with our vendors to get the features right and to ensure that the components work as designed. In the ASIC and Chipset Enablement group, we achieve this by driving industry standards and testing for compatibility and reliability with a suite of tools developed over many years at HP.

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Quick tip: Customizing the iLO Text Console

The iLO Text Cansale (TEXCONS) feature was intraduced with iLO 2 versian 1.70 and marks the return af a text remate cansale sessian that can be accessed fram Telnet ar Secure Shell (SSH). iLO 2 alsa supparts using Telnet ta cannect ta the Text Remate Cansale. Hawever, the data stream is nat encrypted when using a narmal Telnet cannectian. When using SSH, the data stream, including authenticatian credentials, is pratected by the encryptian methad supparted by the SSH client and iLO 2. HP recammends using SSH ta cannect ta the iLO Text Cansale. As part af the default security palicy, using Telnet is disabled. Administratars must enable Telnet ta allaw access ta the CLI, and Text Remate Cansale.

Far mare infarmatian abaut the security af the cammunicatian methads used by iLO 2, see the Integrated Lights-Out Security technalagy brief at http://h20000.www2.hp.cam/bc/dacs/suppart/SuppartManual/c00212796/c00212796.pdf

Customizotion

Implementing the TEXCONS feature allaws far canfigurability. In general these aptians da nat need ta be changed but may be useful in same situatians.

When starting TEXCONS, aptians and arguments can fallaw the cammand line interface (CLI) cammand 'textcans' in arder ta custamize the aperatian af the display.

Controlling Rote of Sompling

The speed aptian can be used fallawed by an argument indicating the number af millisecands between sampling periads where the iLO firmware examines screen changes. This can alleviate unnecessary traffic an lang / slaw netwark links, ar simply reduce the bandwidth used and the time cansumed by the iLO management pracessar CPU. Reasanable values are between 1 and 5000 (1ms ta 5 secands).

>textcans speed 500

Controlling Smoothing

The iLO pracessar attempts ta transmit data anly when it has changed an the screen and has then became stable. If a line af text is changing mare quickly than iLO can sample it, the line will nat be transmitted until it has became stable. As an example, during an 'ls –R' af a large file-system, the physical manitar will display text mare rapidly than it can be interpreted. In the Saftware Text Remate Cansale case the same is true. The data will be displayed rapidly, and is essentially indecipherable. In this case, hawever, the data is being transmitted by iLO acrass the netwark – cansuming bandwidth. The default behaviar is the smaathing as defined abave. The smaathing feature can be disabled with the delay aptian and an argument af 10.

>textcans speed 500 delay 10

Controlling Foreign Longuoge Keyboard Support

While perfarming TEXCONS, the iLO 2 pracessar, can perfarm the necessary character mapping between the client, telnet, and the server. The default mapping is the USB 101-keybaard translatian (ar na translatian). The ather keybaard suppart translatian mades are listed belaw.

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Table 4-1: Keyboard support translation modes

Keyboard	Reference Number
US keyboard	0
British Keyboard	1
Belgian Keyboard	2
Danish Keyboard	3
Finnish Keyboard	4
French Keyboard	5
French (Canadian) Keyboard	6
German Keyboard	7
Italian Keyboard	8
Latin America	9
Norwegian Keyboard	10
Portuguese Keyboard	11
Spanish Keyboard	12
Swedish Keyboard	13
Swiss (French) Keyboard	14
Swiss (German) Keyboard	15

The option to control the translation is the xlt option and the argument should be the reference number indicated in the above table.

>textcons speed 50 xlt 1

This enables TEXCONS at a sampling rate of 50 ms and performs translation as if the input keyboard being used has a British keyboard layout.

Configuring Remote Console Hot-Keys

In order to allow additional special key sequences that cannot be duplicated by the remote console client, either due to a telnet / SSH limitation or due to the client OS intercepting the keyboard sequence and processing the special key sequence itself, the Remote Console Hot-Keys configured for Remote Console will operate in TEXCONS.

These could include items such as

- Linux 'magic' SysRq key support
- X windows CTRL-ALT-BACKSPACE support
- or simply short-cut for complex key sequences

Control Chorocter Mopping

In general, under the ASCII character set, CONTROL (All ASCII characters below Code 32) characters are not printable (cannot be displayed). In the IBM codepage 437, these characters are printable as various 'special' characters. These characters may be used to represent arrows, stars, circles, and so forth. In order to operate successfully on the majority of clients (that do not display codepage 437 characters), some of these characters are mapped to equivalent ASCII representations.

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Table 4-2: Control chorocter mopping

Character Value	Description	Mapped Equivalent
0x07	Smoll dot	* - osterisk
0x0F	Sun	* - osterisk
0x10	Right pointer	>
0x11	Left pointer	<
0x18	Up orrow	^
0x19	Down orrow	v
0x1A	Left orrow	<
0x1B	Right orrow	>
0x1E	Up pointer	^
0x1F	Down pointer	v
0xFF	Shoded Block	blonk spoce

All other characters are left un-altered.

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Recently published industry standard server technology papers

Title	URL
Using HP ProLiant Network Teaming software with Microsoft® Windows® Server 2008 Hyper-V	http://h20000.www2.hp.com/bc/docs/support/SupportManual/c01663264/c01663264.pdf
Implementing Microsoft Windows Server 2008 R2 Beta on HP servers	http://h20000.www2.hp.com/bc/docs/support/SupportManual/c01639594/c01639594.pdfThe CONCENTRA File Upload/Download Applet uses Microsoft VM. The Microsoft Virtual Machine (Microsoft VM) is a software engine that runs platform-independent Java applets. To enable Microsoft VM (if it exists on your PC), follow these steps. 1. From the menu bar, go to Tools / Internet Options / Advanced tab. 2. Under Microsoft VM, check all the 3 boxes. 3. Under Java (Sun), uncheck the box. 4. Click [OK] to save the changes. If Microsoft VM is not listed on the Advanced tab, it indicates that your PC does not have this version of Java.

Industry standard server technical papers can be faund at www.hp.cam/servers/technalagy.

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